Space Weather Technical Forecast

Issued on Tuesday, 03 September 2024 at 00:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-flares expected, slight chance of X-flares. Chance of G1-G2 Geomagnetic storms, mainly Day 2 (04 Sep). Increasing chance of reaching S1/Minor Radiation Storm level.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity is Moderate with five M-flares in the past 24hrs, the peak of which is M2.9 at 02/1343 UTC from AR3807 near the southeast limb. There are eleven sunspot regions on the visible disc. AR3807 in the southwest is the largest region, showing consolidation of the intermediate region with penumbra here starting to mature, and a delta spot developing here. AR3806 near south centre disc has numerous spots, and has now developed a new delta within the trailing spot. Finally, the recently numbered AR3813 in the far southeast appears to be a large and complex region, but due to foreshortening it is hard to distinguish the exact magnetic configuration at present. This region is showing significant looping in SDO imagery, however. It is also being shortly followed by a further new region on the limb, which may be magnetically connected and contributing to the looping. All other regions are relatively simple and stable at present.

No further Earth directed CMEs have been observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar wind parameters as measured by ACE at L1 are at slightly elevated levels, perhaps due to the onset of a weak High Speed Stream (HSS). Wind speeds have ranged from 370-470 km/s, with density around or below average. The Interplanetary Magnetic Field, Bt, was weak increasing to moderate after 02/1730 UTC, peaking at 9 nT. The north-south component, Bz, varied weakly before becoming mostly moderately northward directed. Phi angle was mostly negative (towards the Sun), switching to positive around 02/1945 UTC. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 has been rising in response to the M5.5 flare on 01 Sep but remains below the S1 level, with a peak of 5 pfu at 02/2255 UTC. High energy electron flux (greater than 2MeV) observed at GOES16 was at background to moderate levels. The 24-hour fluence was below the Active threshold, with 3.46e6 integrated pfu observed at 03/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected with a slight chance of isolated X-flares. The main flare risk is currently from AR3806, AR3807 and AR3813.

Solar Wind /Geomagnetic Activity: A filament eruption from 30/2330UTC may give a glancing blow on Day 1 (03 Sep). A large CME off the southeast limb on 01 Sep is expected to mostly pass well behind Earth's orbit, but a faint shock partial halo means glancing impacts at Earth cannot be ruled out for this CME. The timing is low confidence, but perhaps Day 1 or more likely Day 2 (03-04 Sep). Solar winds are at slightly elevated levels, likely due to the HSS from a narrow negative polarity coronal hole, with wind speeds perhaps briefly reaching elevated levels during Day 1 (03 Sep).

On the whole, mainly Quiet to Unsettled (Kp 1-3) activity is expected. There is a chance of G1-G2/Minor-Moderate Storm intervals (Kp 5-6), mainly on Day 2, should there be any peripheral impacts due to the CME from 01 Sep.

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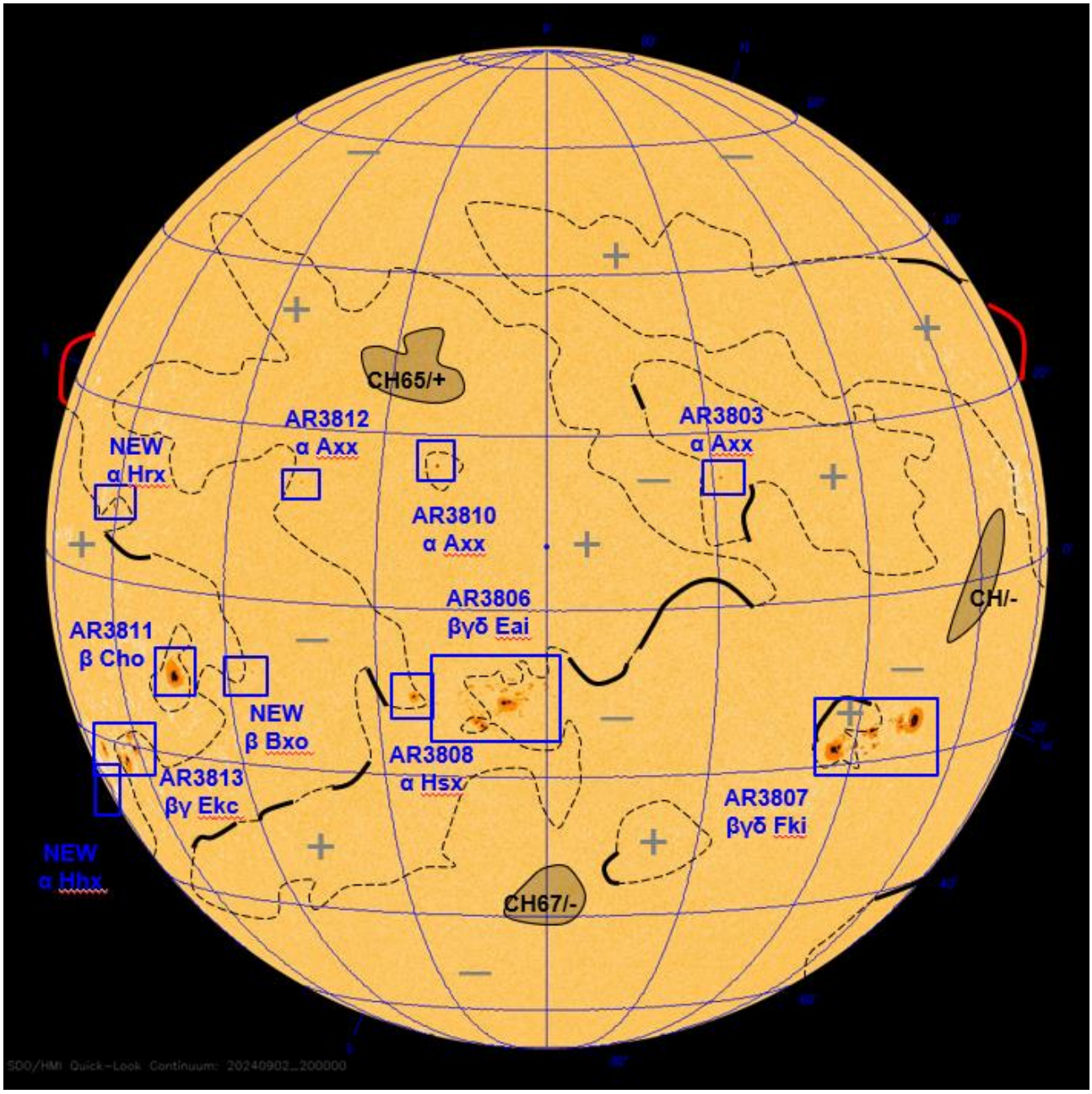
Energetic Particles / Solar Radiation: High energy proton flux is above background levels, but below the S1/Minor Radiation Storm threshold. There is a slightly increasing chance of exceeding S1 in the coming days. High energy electron flux is expected to remain at background to moderate levels, perhaps rising later in the period. There is a slight chance of fluence reaching the Active threshold by the end of the period.

Figure 1. Solar Analysis Valid 02/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

A filament eruption from 30/2330UTC is expected to miss behind Earth's orbit, but the analysis is low confidence due to poor available imagery, and so a glancing blow cannot be ruled out, perhaps on Day 1 (03 Sep). A large eruption off the southeast limb through the UTC afternoon of 01 Sep has been analysed, with the bulk of the CME passing well behind Earth's orbit. However, LASCO C3 imagery does show a faint partial halo, likely shock from the eruption. As such, potential glancing impacts at Earth cannot be ruled out for this CME. The timing is low confidence - although the main portion of the CME will reach 1AU later on Day 1 (03 Sep), the shock is likely travelling slower and is more likely to reach Earth during Day 2 (04 Sep).

Solar winds are at slightly elevated levels, likely due to the HSS from a narrow negative polarity coronal hole straddling the equator in the western hemisphere. Whilst MOSWOC Enlil is suggesting a strong and broad coronal hole fast wind connection, this is not expected to materialise given the small size of the coronal hole, with wind speeds perhaps briefly reaching elevated levels during Day 1 (03 Sep). The polarity of the coronal hole means that significant geomagnetic response is unlikely at this time of year.

On the whole, mainly Quiet to Unsettled (Kp 1-3) activity is expected. There is a chance of G1-G2/Minor-Moderate Storm intervals (Kp 5-6), mainly on Day 2, should there be any peripheral impacts due to the CME from 01 Sep.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	30	5	1
Strong	G3	No	2	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
31/0830	Partial	Filament	NE	400 km/s	03/2100 UTC	Most likely to miss Earth.
01/1549	Partial	AR3813	SE limb	1250 km/s	04/0600 UTC	Partial halo shock (not modelled in Enlil) perhaps glancing Earth. Low confidence.

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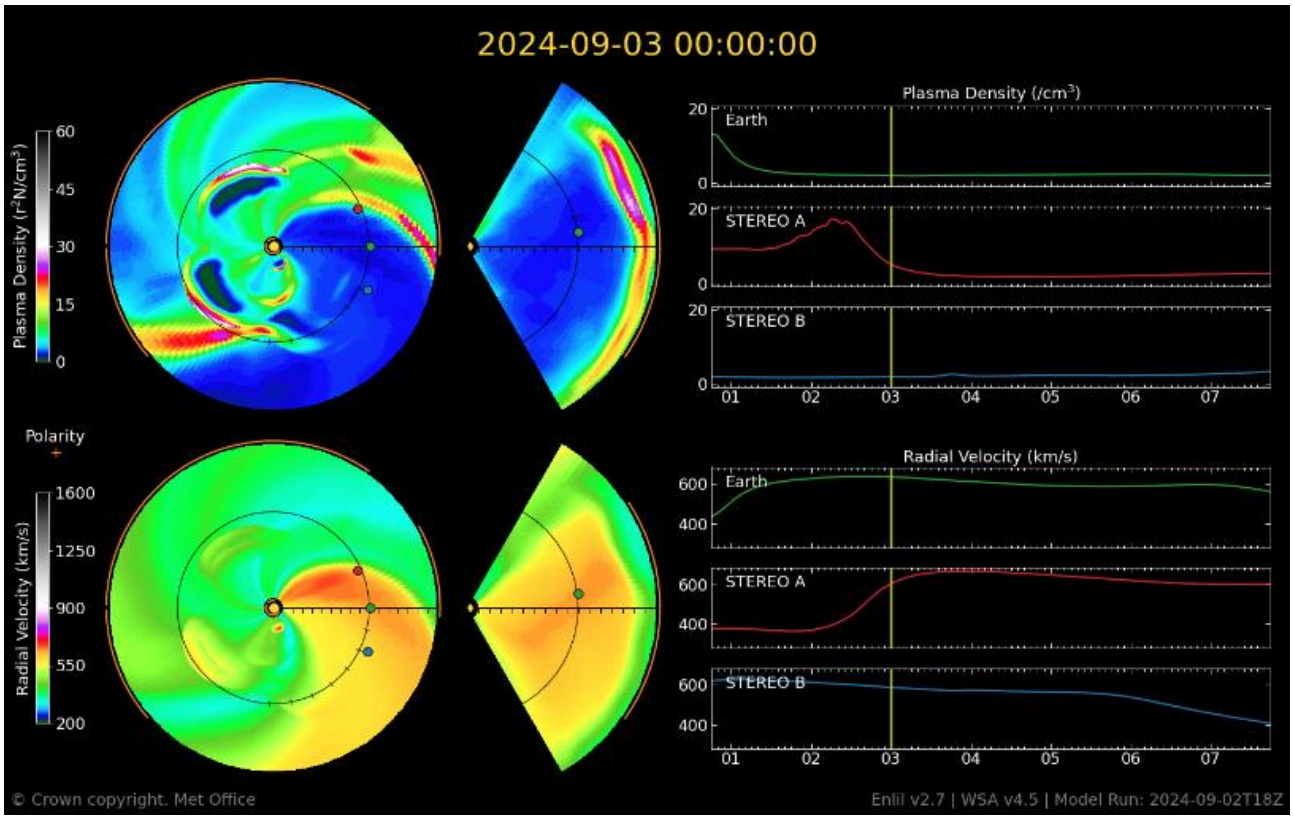
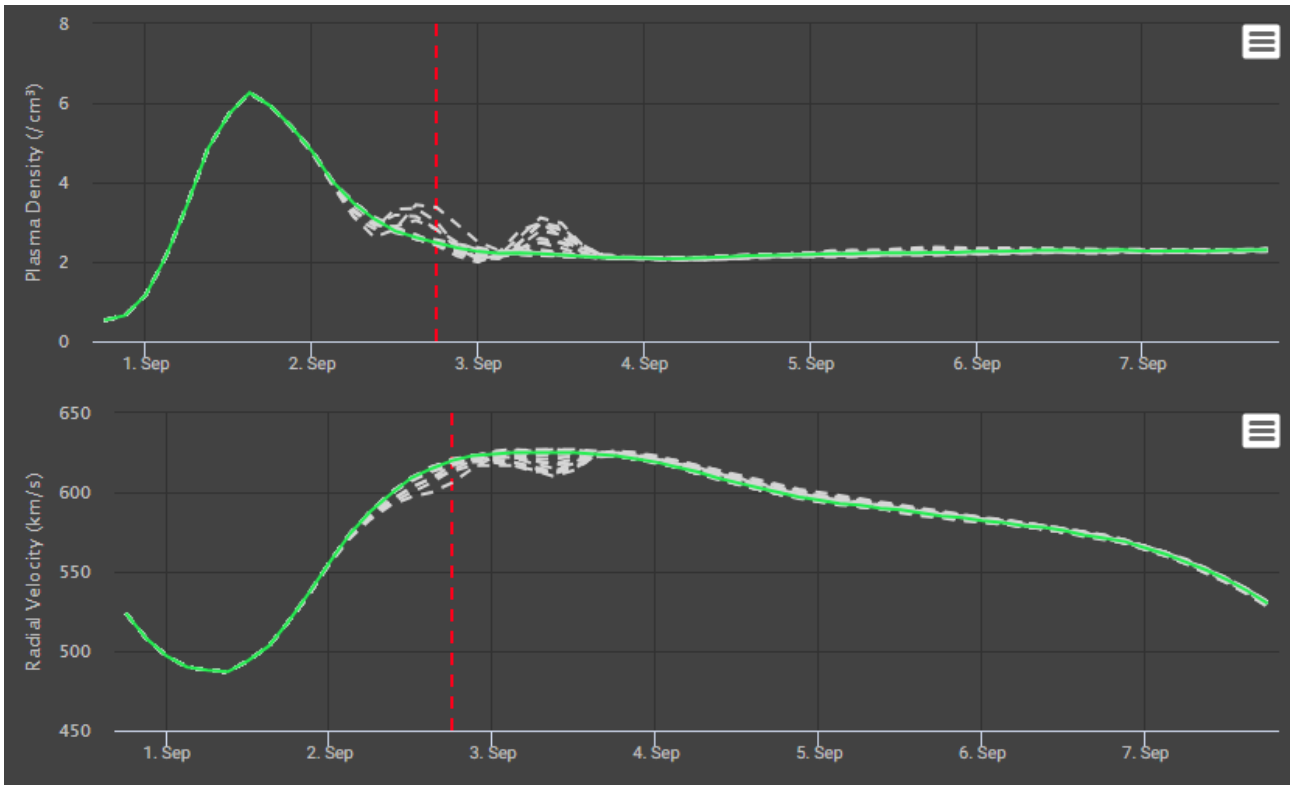
Figure 2: MOSWOC Enlil and ensemble. The CME from 01 Sep is only modelled to the bulk which passes behind Earth, with the shock not modelled, hence it doesn't show up in the ensemble. Enlil is also significantly over estimating the current weak HSS.





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Radio Blackouts - X-Ray Flares:
Activity is Moderate with five M-flares in the past 24hrs, the peak of which is M2.9 at 02/1343 UTC from AR3807 near the southeast limb.

There are eleven sunspot regions on the visible disc. AR3807 in the southwest is the largest region, showing consolidation of the intermediate region with penumbra here starting to mature, and a delta spot developing here. AR3806 near south centre disc has numerous spots, and has now developed a new delta within the trailing spot. Finally, the recently numbered AR3813 in the far southeast appears to be a large and complex region, but due to foreshortening it is hard to distinguish the exact magnetic configuration at present. This region is showing significant looping in SDO imagery, however. It is also being shortly followed by a further new region on the limb, which may be magnetically connected and contributing to the looping. All other regions are relatively simple and stable at present.

Further M-class flares are expected, with a chance of isolated X-class flares. Whilst AR3807 rotates off the disc early on Day 4 (06 Sep), the flare risk from this region will remain until it is around 24 hours over the limb, so a flat trend is maintained throughout.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	80	80	80	80
Very Active	**R3 to R5 X Class**	No	25	25	25	25

Figure 3: X-ray flux at GOES16 and 18 showing several M-flares in the last 24 hours.

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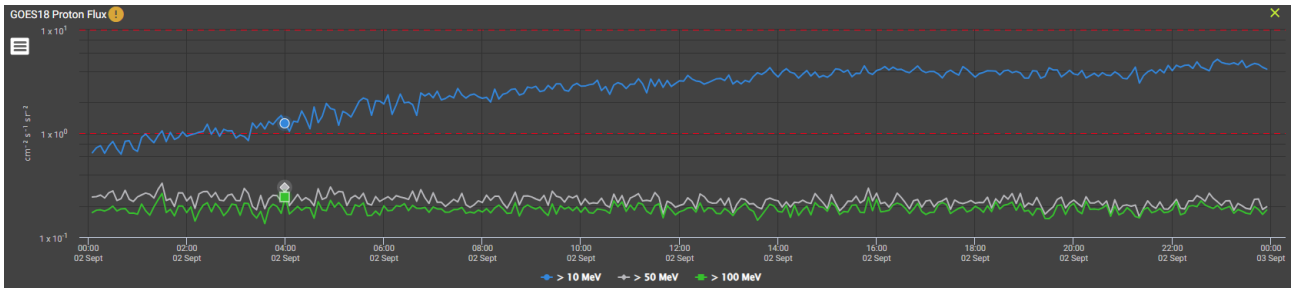
Solar Radiation Storms - (High Energy Protons):
High energy proton flux, as observed by GOES-18, is above background levels in response to the large eruption and M5.5 flare off the southeast limb during the UTC afternoon of 01 Sep. However, the upward trend appears to be levelling off and it is considered unlikely to reach the S1/Minor Radiation Storm threshold at this time, unless further notable flares occur. There are several regions on the disc which could give an increase in proton flux should they produce larger flares, including AR3807 and AR3806. Ordinarily, AR3813 would be considered a low risk of exceeding S1 from its current location, but given it has already produced a proton response at Earth from the east limb, this region will pose an increasing risk of proton flux increases as it rotates westward. Overall, there is an increasing chance of reaching the S1 threshold in the coming days, should there be any larger flares from any of the aforementioned regions.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	25	25
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Proton flux at GOES18, which has risen in response to the M5.5 flare on 01 September, but remains below the S1/Minor Radiation Storm threshold.



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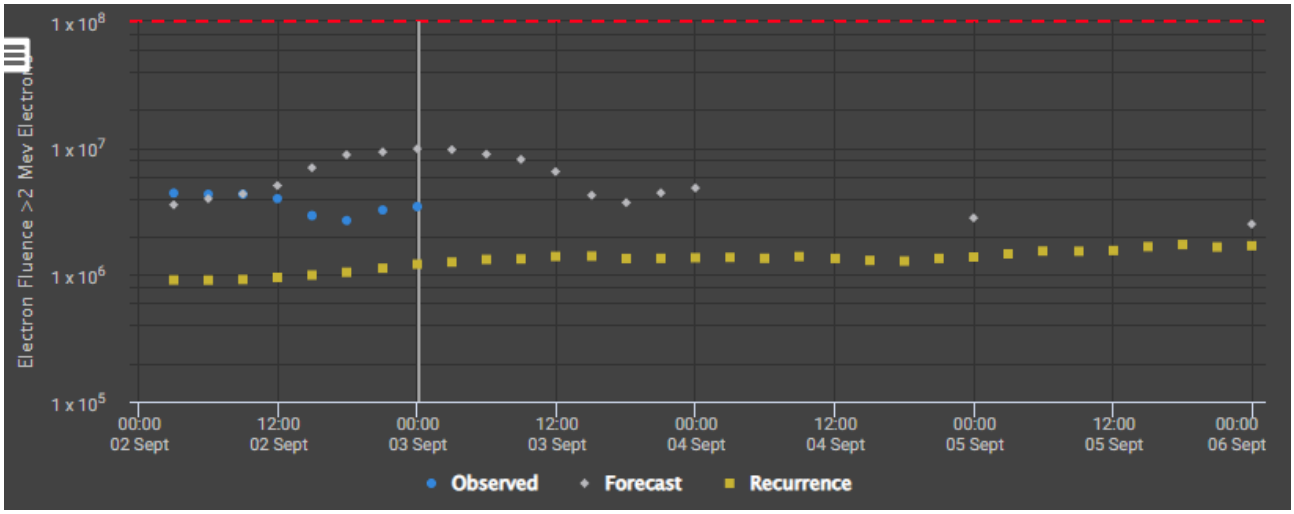
High Energy Electrons Event (≥ 2MeV):
High energy electron flux as observed by GOES-16 is at background to moderate levels, with recent CME effects driving a very minor increase in flux at the diurnal maxima. This is likely to gradually tail off over the next few days in the absence of CME influence. However, there is the potential for some CME shock at Earth on Days 1 to 2 (03-04 Sep), which may cause a sharp drop in electron flux to background levels in the short term. Depending on the level of geomagnetic response to this feature, it may then drive an increase in electron flux later in the period. Confidence is low, however, on whether this CME arrives at Earth or not.

Overall, the 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold for much of this period, perhaps with a rising trend later if we do see CME influence with a geomagnetic response. Therefore there is a slight chance of exceeding the Active threshold by the end of the period. MOSWOC REFM is showing the most likely forecast, below Active, but will not be taking into account any CME arrival.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM showing a below Active forecast over the next three days. It is not taking into account possible CME arrivals, with the potential for a slight rising trend later in the period.



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